EVALUATION OF THE RECYCLING ECONOMIC INFORMATION (REI) STUDY METHODOLOGY

The purpose of this paper is to assess the methodology used for the first REI study, with particular attention to criticism raised by industry experts Jerry Powell and Chaz Miller. In addition, this paper addresses comments and questions raised by state partners. ERG's goals are to develop recommendations for improving the methodology of a future REI study and assist the U.S. Environmental Protection Agency (EPA) in obtaining funding for the project. Another project goal is to develop the methodology in a way that allows stakeholders to compare results from the previous REI study to the results generated by future studies.

Method Review and Recommendations: Economic Perspective

In reviewing the method used in the REI report and making recommendations for improvement, ERG has focused on maximizing the value that can be derived from developing a new REI study. The original REI report detailed the economic impacts of the recycling sector. ERG expects that the final product from a new study can not only provide that information, but also enable the Agency to conduct additional policy analyses. For example, EPA might be interested in using the study to investigate how changes in policies or regulations will impact recycling and the economic effects of recycling. Additionally, EPA might want to study how changes in tax rates and how unexpected changes in input prices (e.g., scrap metal, oil) will affect recycling. Although EPA will be able to conduct these analyses using the original framework of the REI study (i.e., input-output modeling), a more general (and technically complex) method will vastly improve policy analyses conducted using the model. The more complex method that we propose is an extension of the basic input-output (IO) model used in the REI study and thus stays within the IO framework.

Appropriateness of Input-Output Modeling

The use of IO modeling is appropriate in this context since the goal of the analysis is to determine the employment and income impacts associated with recycling. IO modeling, or one of its derivatives, is the preferred method for this type of analysis since it accounts for interconnections in the economy at both a national and regional level.

Although basic IO modeling is appropriate for estimating the impacts of recycling, ERG believes that EPA could improve the method in a future REI study. IO modeling assumes "fixed coefficients" (i.e., fixed values to determine the relationships between a sector and its upstream and downstream sectors). In the case of the first REI study, the model's fixed coefficients assumed fixed prices. ERG suggests switching the method to a more complex type of IO modeling that will enable EPA to relax the assumption of fixed prices and thereby allow market prices to change. This seemingly small change in model selection will have profound impacts for modeling the impacts of recycling and enable EPA to conduct additional policy analyses.

Changes in federal and state policies will alter market prices. As market prices change, the movements of goods and services through an economy also change. A basic IO model with fixed coefficients cannot capture this level of detail in a policy analysis. A Computable General Equilibrium (CGE) model, however, is designed specifically to capture this type of occurrence. Thus, ERG recommends using a CGE model for the future study.

Another consideration that warrants use of a more complex CGE framework is the nature of recycling activities. The REI report identified 30 business sectors where recycling takes place. This multiplicity of

sectors would be better modeled using the more flexible CGE framework. ERG expects that the "fixed coefficients" assumption of basic IO analysis may be too restrictive for an analysis of recycling since recycling takes place in multiple sectors. This is especially true if EPA wishes to conduct future policy analysis with the model. A CGE model would alleviate that restriction, allowing for more accurate modeling of recycling impact.

IMPLAN Versus Other Available Data/Software

The original REI study used IMPLAN to perform the IO modeling. IMPLAN is a combined data system and IO model. Other possible models include the Regional Industrial Multiplier System (RIMS) II (developed by the Bureau of Economic Analysis) and the Regional Economic Models, Inc. (REMI) model. In terms of complexity, IMPLAN lies in the middle, with RIMS II being less complex and REMI being significantly more complex. Naturally, the cost of the model increases with complexity. Actual cost for purchasing one of these models will depend on a variety of factors.

ERG suggests that EPA use at least IMPLAN and seriously consider use of REMI. However, if budgetary requirements constrain the completion of this analysis, RIMS II can be used. This is not to suggest that RIMS II is an inferior model that provides suspect results. In fact, RIMS II has been found to be quite reliable in replicating the results of detailed survey-generated IO analyses. ERG's motivation for suggesting use of "at least" IMPLAN is that the previous analysis used IMPLAN. Thus, using either IMPLAN or REMI would guarantee the same level of detail for the results.

ERG also recommends that EPA use one of these "off the shelf" models rather than developing an IO model on its own. Developing reliable IO models is a complex process and any cost savings in product purchases would be more than offset by model development costs.

If EPA decides the go with a more complex CGE model, as discussed above, then REMI will need to be used. The IMPLAN framework is an IO model and does not allow for the flexibility of a CGE model. REMI, on the other hand, is a CGE model that also allows for basic IO analysis. Thus, a run of the model could be done that would be comparable to the previous REI analysis even if REMI is used. Once again, in ERG's opinion, the more complete CGE framework would provide a more realistic analysis of recycling impacts.

Include Tonnage of Recycled Materials (In-state, Out-of-state and Out-of-country)?

One state commenter asked if the next REI study could analyze the movement of materials within a state, between states, and internationally without double counting the data. For a national economic study, the origin or movement across state lines does not affect the outcome, but becomes important when reviewing the economics at a state level. For example, a state may have collection and processing industries but few or no end users. To avoid double counting, the recyclers and processors would need to be surveyed to determine where they sell their recovered materials. States do not typically track this information. ERG did quantify the movement of recovered materials between counties and in and out of the state of Kansas, but it was a snapshot in time and not continued past the study. Developing state-specific information in the next REI study undoubtedly would be beneficial to the states, but to do so for all states would probably be too ambitious for the anticipated budget.

Include Figures on Reduction in Disposal Costs by Utilizing Recycled Materials?

Expanding the study to capture the disposal economics is a valid idea. However, we would also have to include disposal from the recycling side of the equation. For example, recycling paper reduces the

quantity of paper entering the landfill, but the sludge from a deinking mill (which utilizes recovered paper) is also disposed and would need to be included. If we expand the study to include disposal, to avoid criticism, we would also need to investigate the impact of the recycling process on air and other environmental emissions. The results of this type of analysis are uncertain and would need to be done on a product-by-product basis. In order to do an environmental benefit/impact analysis, we would need to have more complete tonnage data than was captured in the previous study. Additionally, a parallel analysis of the alternative system (i.e., 100 percent virgin material) would need to be conducted to make a comparison and therefore a determination of the savings (or costs) of recycling. Inclusion of disposal cost is not as simple as the comment may suggest.

Comments on Overestimation of Indirect Benefits and Bias of Previous REI Study

ERG was not able to find any evidence of overestimation or of overt bias *in the economic IO modeling*. The multipliers in the IO method are not chosen, but are calculated from the data. This limits the possibility of using multiplier that is too high. In reviewing the estimated multipliers, we expect that they are at least ordinally in line with what might be expected. That is, the estimated multipliers are less than those for manufacturing, but more than those for retail and other "downstream" industries (i.e., closer to final consumers). Additionally, there are no signs that the *IO modeling* was influenced by any pro-recycling bias.

The potential for overestimation and bias can occur, however, at the stage leading up to the IO modeling. In estimating the direct economic activity associated with recycling (i.e., number of employees and numbers of establishments), a number of assumption are made. For example, the REI analysis assumes that all of employees in the steel mills using a basic oxygen furnace and all those making bottles in the container industry are "recycling employees." These types of assumptions lead to larger multipliers since they potentially overstate recycling's direct economic effect.

Use of Survey Results to Derive Direct Numbers

The survey used in the REI analysis to fill in some of the direct economic impact numbers may lead to some bias. The method used in the REI analysis was to rely on existing data as a first data source for each of the 30 business sectors. If a business sector did not have existing data, then a survey was conducted if a sampling frame could be developed. If that was not possible, the study relied on expert opinion combined with any partially existing data. The survey, however, was used to develop the direct estimates for 12 of the 30 business sectors (40 percent).[1]

Appendices D and E of the report contain the survey instrument and an analysis of the survey results, respectively. ERG was unable, however, to fully assess the validity of the survey. ERG feels that too little information was provided in survey analysis section to fully assess the implementation of survey. Missing from this section are:

- Justification for the sample size used
- Description of the sample selection design
- Assessment of the representativeness of the sampling frame
- Reported values for standard deviations for the survey data

[1]Drop-off collection was not included in the first study. This method of collection should be investigated further to see if the data are available.

- Assessment of the representativeness of the data
- Information to calculate a response rate

Based on the information that is provided, however, ERG can only conclude that the final sample has the potential to be significantly biased. The report notes that a sample of 627 establishments was chosen, which represented 9.5 percent of the establishments in the "study database." From that 627 they received 212 usable responses, or 33.8 percent of the surveys sent out.[2]

Methods Used By States

ERG reviewed REI and other recycling economic impact studies performed by states and other entities. ERG reviewed the methodology used in the reports from:

- California
- Florida
- Illinois
- Indiana
- Iowa
- Michigan
- Minnesota
- Northeast Recycling Council (NERC)
- Ohio
- Wisconsin

ERG limited review of these studies to the method used. The primary purpose of our review was to identify differences in methods from the REI study and to assess whether those difference presented opportunities to improve a future REI study. A complete assessment of the alternative method was beyond the scope of this memo. A complete assessment would require interviews with the staff that developed the other methods as well as reviewing data that could be used in the method. Rather, we would refer to our assessment as more of a screening process to determine potentially fruitful expansions of the REI methods.

Based on our review, we expect that the studies developed by Iowa and Minnesota offer potential improvements to the REI method. Before discussing these potential improvements, we offer a brief overview of our assessment of the other reports.

- The reports for Florida, Illinois, Ohio, Indiana, and NERC were conducted using the same method as the national REI study and therefore offered no significant differences in methods.

- The California and Wisconsin studies each appear to have used a method similar to that of the national REI study in that both use IMPLAN to estimate economic impacts. The two reports, however, provide only a cursory summary of the methods used and thus it was not possible for ERG to make a definitive judgement on the method comparability.

[2] This is not the same as a response rate. A response rate would account for out of scope and out of business establishments in the sample. Thus, the actual response rate for this survey was most likely higher than 33.8 percent.

The Iowa analysis followed the national REI methodology for estimating economic impacts (i.e, it used the IMPLAN model). The report also added a commodity flow analysis which examined demand and supply imbalances for recycled commodities in Iowa. A similar analysis at the national level may provide a good deal of information on how recycling markets are working. Further research would be required, however, to assess the feasibility and data needs for such an analysis.

The Minnesota study followed a method similar to that of the national REI study, but used the REMI model instead of the IMPLAN model. Unfortunately, the report provides little indication of the additional features of the CGE framework employed by the REMI model. Nevertheless, a move to a CGE framework has precedent in the Minnesota analysis and provides future REI researchers a resource to contact to assist in issues associated with using a CGE framework for recycling.

Methodological Recommendations

Based on the comments we have provided above and our knowledge of recycling issues, ERG makes the following methodological recommendations:

- **Move from a basic IO model to a more comprehensive CGE framework.** This will allow for more detailed economic modeling of recycling's impact and allow for policy analysis in the future.

- **Use the REMI model instead of the IMPLAN model.** This is consistent with the previous recommendation. In fact, a switch to a CGE framework must be accompanied by use of the REMI model.

- **Explore the possibility of adding in a commodity flow analysis.** This will provide EPA with an assessment of demand and supply imbalances in recycling markets.

- **Add in an analysis of recycling benefits.** This could include estimated reduced costs from using recycled materials as well as estimated reduction in greenhouse gases associated with recycling. This would tie in with recent government efforts to measure the impact of environmental programs in terms of environmental improvements. Furthermore, if EPA switches to a CGE framework and conducts policy analyses with the expanded model, the results of those analyses can be phrased in terms of environmental impacts.

Method Review and Recommendations: Recycling Industry Definition

Include 100 Percent of Manufacturing Employees Regardless of Percentage Recycled Materials Used in Feedstock?

The assumption that received the most criticism was the inclusion of 100 percent of the manufacturing employees regardless of the percentage recycled materials used in the feedstock. We agree that this assumption should probably be changed. Our suggestion is to allocate the economic benefits to only that portion of the employees that corresponds to the percentage recycled feedstock. For example, if glass manufacturers use 25 percent recycled glass in new glass containers, then the economic benefit would only reflect 25 percent of employees. One could argue that after the feedstock is mixed any step in the process contains 25 percent recovered material. Due to the impact that this assumption has on the final analysis, any alternate assumption would need to be reviewed more thoroughly on a material-by-material basis and discussed with all stakeholders. **Additionally, changing this assumption would affect the**

comparability of the first study with the second. It might be possible to provide analysis at the 100 percent level to make a comparison, but then provide analysis with the new assumption to move forward. This would, however, greatly complicate the study.

We suggest approaching this controversial assumption in a manner similar to the methodology assumptions used in a lifecycle assessment analysis of energy use, emissions, and end of life (e.g., recycling or disposal). Environmental burdens are allocated to the various steps within a system. If, for example, we were looking at a paper mill we would not allocate all of the energy use and emissions to the use of recovered paper. Similarly, we would not allocate all of the benefits to the recovered paper. We would allocate the appropriate burdens to the recovered feedstock and allocate the appropriate burdens to the virgin feedstock. Since the same employees are using both feedstocks and they cannot be counted twice, they would be allocated on a percentage basis for the REI analysis. Using such sources as the American Forest and Paper Association's (AF&PA) annual Capacity Survey (apparently not used in the REI report), it will be possible to allocate production of various grades of paper and paperboard by input of virgin and recycled inputs. Some products are made of 100 percent virgin fibers (and thus would be excluded); some are made of 100 percent recycled fiber (and thus would be totally included). Other paper products are made of a mixture of virgin and recycled fibers; their employment would be allocated based on the percentage of recycled material used.

Combining of Home, Pre- and Postconsumer Recovered Materials into One Category

The combining of home, pre- and postconsumer recovered materials into one category was also criticized. Home scrap is the scrap created and reintroduced into the process within the same facility. The study states that home scrap was not included *(although Jerry Powell mentioned home scrap in his editorial).* In our opinion, using home scrap within a plant does not increase the number of jobs within a manufacturing facility and therefore should not be included. All industries (not just recycling industries) recover and reuse home scrap, if possible. We do feel that a distinction can and probably should be made between pre- and postconsumer recovered materials. The two should be treated the same but shown separately to illustrate the impact of preconsumer recovery. It is possible, however, that this separation could lead to unwelcome attention from those who want to recognize only postconsumer recycling.

Include Steel Mills Using Basic Oxygen Furnaces?

This issue (for steel mills) is the same as the discussion above for paper mills. In Greg Crawford's February 20, 2002, response to Jerry Powell, the following numbers were given for basic oxygen steel furnaces, which he says produce 31.7 percent recycled content:

Home scrap	0.8 million tons
Industrial scrap	5.9 million tons
Postconsumer	12.1 million tons
	18.8 million tons

While we feel that all scrap except home (in-house) scrap should be included, some observations are in order. First, industrial scrap is derived from cuttings, trimmings, etc., generated in the manufacture of a product such as cans. Second, postconsumer scrap used by the steel industry is derived largely from shredded auto bodies, dismantled bridges, railroad rails and wheels, and a host of other sources. Recycled steel recovered from municipal solid waste (MSW), as compiled in EPA's MSW Characterization report, was only 4.6 million tons in 2000, and this came mostly from appliances and steel cans recovered by

scrap dealers, from incinerator ash, and from curbside collection programs (cans). Thus, "postconsumer" recovery as perceived by most stakeholders is very small compared to the total recovered; this may cause some surprises.

Include Source Reduction Data?

One state suggested that EPA expand the REI study to include source reduction data in addition to recycling. Source reduction data are very difficult to obtain—it is hard to measure something that does not exist. We would expect that including source reduction would have little if any effect on the overall study. In theory, if less were made, then jobs would most likely be lost and not gained. Our recommendation is to continue including recycling and reuse only.

Should the Study Separate Manufacturing Jobs from "Recycling" Jobs?

The first study did display collection, processing and manufacturing separately. We would suggest keeping this same format.

Should the Following Sectors Should Be Included in a Future Study?

- Food – yes, food composting
- Reuse (e.g., start-ups that sell used building materials) – already included
- Carpeting – yes
- Construction and Demolition (C&D) – pavement mix producers (asphalt and aggregate) are already included in the first study.[3]
- Tire-derived fuel – we can include if EPA wants to include fuel products
- Waste-to-fuel – we can include if EPA wants to include fuel products
- Small niche/specialty recycling (more info available?) – national data not available

Methodological Recommendations

- **Include critics from the first study in early discussions for the second study.** Although this paper captures comments received thus far by the study's critics, including these individuals in the planning for the next study will help ensure that the next methodology adequately addresses their concerns.

- **In the introduction, provide a better discussion of the definition of recycling.** Stakeholder perceptions are colored by their own perspectives of what constitutes recycling. As recognized in the REI report, there is home (in-house) scrap, industrial (preconsumer) scrap, and postconsumer scrap. Historically, EPA has generally recognized only postconsumer scrap recovered from MSW, and that is the perception of many stakeholders. Further, it is postconsumer scrap collected via curbside residential collection and dropoffs that is recognized by most state and local government recycling staffs. In fact, most scrap recovery takes place from industrial plants (e.g., product fabrication), commercial postconsumer activities (e.g., wholesalers and retail grocery stores), and other postconsumer sources excluded from EPA's MSW Characterization report

[3]Steel recovered from C&D is the only other material recovered in large quantities. The recovered steel is already included in the steel mill numbers. The employment that is missing would be the collection and processing of the steel from C&D. This would be difficult but not impossible to estimate.

(e.g., obsolete automobiles, highway concrete and asphalt). The report could be an educational tool to broaden perspectives on recycling at all levels of government.

- **Improve the transparency and presentation of results.** The existing REI report is difficult to understand, even for a sophisticated reader. The report assumes significant previous knowledge of the recycling/reuse industry. ERG recommends that the introduction and presentation of results be improved by including up-front definitions and assumptions. A simple flow diagram showing collection, processing, manufacturing, and reuse/remanufacturing would help. The presentation of results could be correlated with the flow diagram to clarify where in the recycling/reuse process the economic benefits accrue.

- **Use the percentage of recycled feedstock to determine the numbers of employees "attributable" to recycling for the industries included.** If EPA and other stakeholders concur, respond to criticisms (e.g., by Jerry Powell and Chaz Miller) by allocating employees in plants that use a mixture of virgin and recycled materials on a percentage basis, as described above. Keep in mind, however, that this may complicate comparisons between the two studies and/or increase costs of the study.

- **Include an additional category of manufacturing workers whose jobs are wholly or partially dependent on using recyclables as raw materials.** Manufacturing workers whose jobs are wholly dependent on using recyclables as raw materials is quantifiable. Quantifying jobs that are partially dependent on recyclable materials is more difficult. Industry and recycling advocates would probably have a difficult time agreeing on this point.

- **Better demonstrate the dependence of the American economy on recyclables as raw materials.** We can demonstrate using basic numbers without an in-depth analysis